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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/593,254

09/18/2006

Tsuyoshi Takahashi

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01/21/2009

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EXAMINER

MILLER, JR, JOSEPH ALBERT

ART UNIT

PAPER NUMBER

1792

NOTIFICATION DATE

DELIVERY MODE

01/21/2009

ELECTRONIC

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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<b>Office Action Summary</b>	<b>Application No.</b> 10/593,254	<b>Applicant(s)</b> TAKAHASHI ET AL.	
	<b>Examiner</b> JOSEPH MILLER JR	<b>Art Unit</b> 1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 31 December 2008.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) 8-18 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-7, 19 and 20 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☒ Claim(s) 1-7, 9-15, 19 and 20 are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All    b) ☐ Some \*    c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)            | 4) <input type="checkbox"/> Interview Summary (PTO-413)           |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)   | Paper No(s)/Mail Date. _____                                      |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date <u>03/28/2007, 12/18/2006</u> .                                  | 6) <input type="checkbox"/> Other: _____                          |

## **DETAILED ACTION**

### ***Election/Restrictions***

Applicant's election with traverse of Group 1, claims 1-7, 19 and 20 in the reply filed on December 2, 2008 is acknowledged. The traversal is on the ground(s) that the invention holds more than one technical feature which is not taught in the prior art. The second special technical is stated by applicants as being the specifically defined substrate temperature setpoint/range. This is not found persuasive because setting a temperature of a substrate at a specific setting is very well known in the art and a part of standard process optimization. Additionally, setting specific temperatures with decomposition temperatures of components in mind would be obvious to one of ordinary skill in the art.

Furthermore, the specific temperatures chosen in the prior art (Rangarajan (Thin Solid Films, 419, 2002, p1-4) for example) lie within the ranges required by instant application however the specific purpose of setting the temperature range is not discussed by prior art authors.

The requirement is still deemed proper and is therefore made FINAL.

### ***Claim Rejections - 35 USC § 102***

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

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A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-5 are rejected under 35 U.S.C. 102(b) as being unpatentable over Rangarajan (Thin Solid Films, 419, 2002, p1-4) as evidenced by Soulet (Optimizing, Materials & Gases, Semiconductor Fabtech – 27<sup>th</sup> Edition) and Smith (7,070,833).

Rangarajan teaches a process to deposit hafnium silicate films (abstract). Rangarajan teaches the placing of a substrate in a chamber to form a hafnium silicate film by flowing a metal alkoxide and a gas of silicon hydride (Section 2, experimental).

Regarding the limitation on heating the substrate, Rangarajan teaches performing the process at 410 degrees Celsius (experimental). Though Rangarajan does not teach that this temperature is specifically higher than or equal to the decomposition temperature at which the metal alkoxide decomposes, the decomposition temperature of the precursor is around or above 234 degrees Celsius according to Soulet (p3, last sentence on page), thereby teaching within claimed temperature range. Also, though Rangarajan does not explicitly teach that the temperature is below the decomposition temperature of silicon hydroxide, Smith teaches that the decomposition of silicon hydride gas is from about 300 to about 600 degrees Celsius, thereby teaching within claimed temperature range.

Though Rangarajan does not explicitly state that the gases are introduced through respective passages separated from each other, he teaches separate delivery of the chemicals in the description of chemical delivery (experimental section). The

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hafnium precursor is “delivered” (i.e. to the substrate) with a flow of argon as a carrier gas. The silane is added with a helium dilution. The silane flow is clearly with helium and the hafnium precursor held under deliberate conditions prior to delivery with a specific purity of argon as the carrier gas. The hafnium precursor is specifically held at a temperature below the decomposition temperature (31 degrees C) until it reaches the heated substrate (experimental).

Regarding claim 2, the hafnium (metal) precursor used is HTB and therefore has a t-butoxide ligand.

Regarding claim 3, though Rangarajan does not explicitly teach the result of producing an intermediate of isobutylene, however, since the prior art and the present claims teach all the same process steps, the results of producing an intermediate of isobutylene obtained by applicants process must necessarily be the same as those obtained by the prior art. It is disclosed in the specification [0043, 0044] that decomposing HTB at temperatures over 350 degrees Celsius produces isobutylene. Since the prior art teaches the decomposition of HTB at 410 degrees Celsius, it follows that an intermediate of isobutylene must necessarily be produced. isobutylene.

Regarding claim 4, Rangarajan teaches the use of HTB.

Regarding claim 5, the temperature taught by Rangarajan is higher than that required by instant claim.

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1-5 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rangarajan (Thin Solid Films, 419, 2002, p1-4) as evidenced by Soulet

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(Optimizing, Materials & Gases, Semiconductor Fabtech – 27<sup>th</sup> Edition) and Smith (7,070,833) in view of Buchanan (6,984,591) and Kopacz (6,368,987).

Rangarajan teaches a process to deposit hafnium silicate films (abstract).

Rangarajan teaches the placing of a substrate in a chamber to form a hafnium silicate film by flowing a metal alkoxide and a gas of silicon hydride (Section 2, experimental).

Regarding the limitation on heating the substrate, Rangarajan teaches performing the process at 410 degrees Celsius. Though Rangarajan does not teach that this temperature is specifically higher than or equal to the decomposition temperature at which the metal alkoxide decomposes, the decomposition temperature of the precursor is around or above 234 degrees Celsius according to Soulet (p3, last sentence on page), thereby teaching within claimed temperature range. Also, though Rangarajan does not explicitly teach that the temperature is below the decomposition temperature of silicon hydroxide, Smith teaches that the decomposition of silicon hydride gas is from about 300 to about 600 degrees Celsius, thereby teaching within claimed temperature range.

Rangarajan does not explicitly teach introducing the gases through respective passages separated from each other. For the reasons discussed above, the examiner takes the position that the gases must inherently be introduced in separate passages in the process of Rangarajan, however, the Examiner additionally provides the following.

Buchanan teaches deposition of films containing metal and silane where the materials are introduced into the chamber at the same time, but through separate inlets (col 18, line 45- col 19, line 9).

Kopacz teaches an apparatus and method for depositing a film by CVD where the first and second reactants are flowed separately through the showerhead (abstract).

It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the introduction of silane and hafnium sources through separate inlets as taught by Buchanan to the hafnium silicate film formation technique of Rangarajan as introducing the silane and hafnium components through separately inlets would allow them to be introduced simultaneously as taught by Buchanan (col 18, line 45- col 19, line 9). It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the use of separate inlets further for the purpose of avoiding premature deposition of the reactants in the system (Kopacz, abstract).

Because Rangarajan teaches the heating of the substrate to a temperature of 410 degree Celsius, it is obvious that this is the desired reaction temperature therefore it would be obvious to apply Rangarajan in view of Buchanan where the temperature that the gas is introduced at is lower than the decomposition temperature of the hafnium precursor so that the reaction can occur (only) on the substrate. Concern with the temperature of the hafnium precursor as Rangarajan teaches maintaining the hafnium precursor with a bubbler temperature of 31 degrees Celsius (experimental), well below the self decomposition temperature.

Regarding claim 2, the hafnium (metal) precursor used is HTB and therefore has a t-butoxide ligand.

Regarding claim 3, though Rangarajan does not explicitly teach the result of producing an intermediate of isobutylene, however, since the prior art and the present



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claims teach all the same process steps, the results of producing an intermediate of isobutylene obtained by applicants process must necessarily be the same as those obtained by the prior art. It is disclosed in the specification [0043, 0044] that decomposing HTB at temperatures over 350 degrees Celsius produces isobutylene. Since the prior art teaches the decomposition of HTB at 410 degrees Celsius, it follows that an intermediate of isobutylene must necessarily be produced.

Regarding claim 4, Rangarajan teaches the use of HTB.

Regarding claim 5, the temperature taught by Rangarajan is higher than that required by instant claim.

Regarding claim 19, Rangarajan clearly teaches the use of the hafnium silicate film as a gate dielectric (introduction). Buchanan teaches the use of a silicon dioxide coated substrate for the deposition of a high k layer (col 23, line 58 – col 24, line 55). It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the use of a silicon dioxide coated substrate as taught by Buchanan to the metal silicate layer of Rangarajan as one could apply the silicon dioxide substrate with a reasonable expectation of success in forming a gate stack for a semiconductor application.

In regards to further applying a gate electrode on the gate dielectric, Buchanan further teaches the formation of a transistor including a gate stack which comprises a gate electrode (item 52 in Fig. 4) which has been deposited over a hafnium silicate layer (layer 56) (col 23, line 55 – col 24, line 55). (In alternative, layers 55 and/or 57 may be a metal silicate; with hafnium silicate being taught as a known silicate). It would have

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been obvious to one of ordinary skill in the art at the time of the invention as the step of adding a gate electrode to a gate structure/gate dielectric is well known in the art as exemplified by Buchanan. It would be obvious to apply the gate structure of Buchanan to the gate dielectric of Rangarajan because one could apply the gate electrode to the gate dielectric with a reasonable expectation of success in forming a gate structure based on Buchanan's successful formation of a gate structure for a transistor. Furthermore, one intent of the gate dielectric is to protect the underlying silicon during processing (i.e. formation of the remainder of the gate structure).

Claims 6 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rangarajan (Thin Solid Films, 419, 2002, p1-4) as evidenced by Soulet (Optimizing, Materials & Gases, Semiconductor Fabtech – 27<sup>th</sup> Edition) and Smith (7,070,833) in view of Buchanan (6,984,591) and Kopacz (6,368,987) as applied to claim 1 above and in further view of Metzner (2003/0232506).

Rangarajan teaches a process to deposit hafnium silicate films (abstract). Rangarajan teaches the placing of a substrate in a chamber to form a hafnium silicate film by flowing a metal alkoxide and a gas of silicon hydride (Section 2, experimental). Regarding the temperature limitation, Rangarajan teaches performing the process at 410 degrees Celsius, meeting the temperature criteria as explained above in claim 1 rejection.

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Buchanan teaches deposition of films containing metal and silane where the materials are introduced into the chamber at the same time, but through separate inlets (col 18, line 45- col 19, line 9).

Rangarajan in view of Buchanan therefore further teaches the supply of the gases via different inlets into the process chamber where the inlet temperature for the introduction of the metal alkoxide is lower than a self-decomposition temperature.

Regarding claim 6, Rangarajan in view of Buchanan does not teach the use of disilane as the silicon hydride source.

Metzner teaches a process for the formation of a hafnium silicate layer deposited by a CVD method in the temperature range of about 325 to about 700 degrees Celsius [0049-0052]. Metzner teaches that silane or disilane may be used as the silane source [0052].

It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the use of disilane as taught by Metzner in the formation of a hafnium silicate layer as an alternative to the silane taught by Rangarajan as one would have a reasonable expectation of success in forming a silicate film with disilane based on Metzner's successful use of disilane to form a hafnium silicate film.

Regarding claim 7, the temperature taught by Rangarajan is lower than that required by instant claim; the temperature range taught by Metzner also teaches in claimed range.

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Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Rangarajan (Thin Solid Films, 419, 2002, p1-4) as evidenced by Soulet (Optimizing, Materials & Gases, Semiconductor Fabtech – 27<sup>th</sup> Edition) and Smith (7,070,833) in view of Buchanan (6,984,591) and Kopacz (6,368,987) as applied to claim 19 above and in further view of Johnson (WO02/075801).

Rangarajan teaches the use of the hafnium silicate film as a gate dielectric (introduction). Buchanan teaches the use of a silicon dioxide coated substrate for the deposition of a high k layer (col 23, line 58 – col 24, line 55) and the formation of a gate electrode on a gate dielectric.

Rangarajan teaches a process to deposit hafnium silicate films (abstract). Rangarajan teaches the placing of a substrate in a chamber to form a hafnium silicate film by flowing a metal alkoxide and a gas of silicon hydride (Section 2, experimental) at 410 degrees Celsius. Buchanan teaches deposition of films containing metal and silane where the materials are introduced into the chamber at the same time, but through separate inlets (col 18, line 45- col 19, line 9).

Rangarajan in view of Buchanan therefore further teaches the supply of the gases via different inlets into the process chamber where the inlet temperature for the introduction of the metal alkoxide is lower than a self-decomposition temperature and teaches the formation of a high k layer (hafnium silicate film) on a silicon dioxide film but does not teach the formation of a silicon oxide film by the exposure of the substrate to UV excited oxygen radicals.

Johnson teaches that the formation of a gate-quality oxide using UV radiation excited oxygen is known in the art (page 6, 2<sup>nd</sup> paragraph).

It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the use of UV excited oxygen radicals to create a gate quality silicon oxide film for manufacture of a gate as the exposure of the silicon substrate to oxygen radicals it would allow one to react silicon with oxygen without a plasma discharge (Johnson, page 6).

### ***Conclusion***

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Eguchi (2003/0127640) teaches a method for forming a hafnium silicate film.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOSEPH MILLER JR whose telephone number is (571) 270-5825. The examiner can normally be reached on Monday through Thursday from 8am to 4pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks, can be reached on 571-272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR.

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Status information for unpublished applications is available through Private PAIR only.

For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

/JOSEPH MILLER JR/  
Examiner, Art Unit 1792

/Timothy H Meeks/  
Supervisory Patent Examiner, Art Unit 1792